Multi-stage Cascaded Stirling Refrigerator

July 5, 2013

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Applications:

- Oxygen production
- Natural gas liquefaction for fleet vehicles
- Cooling for semiconductor fabrication
- Medicine / cryobiology
- Cryogenic cooling of high temperature superconductor devices (e.g. superconducting magnets in MRIs, SQUIDs, and smart grid electric power transmission)

Benefits:

- Simplicity
- Reliability
- High-efficiency
- High-capacity
- Substantial cooling watts per dollar
- Utilizes inert gas as opposed to ozone-depleting CFCs

Summary:

Conventional pulse-tube refrigerators may be robust and reliable, but they fall short of their theoretical peak efficiency—the inner networks of these refrigerators dissipate residual acoustic power flowing from the cold heat exchanger to create appropriate conditions at the refrigerator inlet. In fact, the traditional pulse-tube refrigerator loses as much as 30 percent of its efficiency through this process. Though the ability to recapture that energy would improve the efficiency of the machine, costly trade-offs have often plagued those upgrades. Previous attempts have, for example, required additional moving mechanical components or created closed-loop streaming paths, both of which complicate the manufacturing process and reduce the reliability of the apparatus.

Los Alamos National Laboratory (LANL) researchers have developed a multi-stage refrigerator, designed to recapture and utilize the acoustic energy that would ordinarily be wasted in traditional Stirling configurations. The novel design recovers power to drive successive cooling phases, thereby increasing the cumulative efficiency of the device and avoiding the disadvantages associated with previous solutions. Instead of CFCs or HCFCs, the Multi-stage Cascaded Stirling Refrigerator uses environmentally-benign helium as the

working fluid. The Multi-stage Cascaded Stirling Refrigerator has potential uses in oxygen production, natural gas liquefaction for mass transit, and cryogenic cooling of high temperature superconductor devices. In applications for which watts per dollar are of chief concern, this refrigerator will maximize efficiency, capacity, and cooling performance.

Development Stage:

Technology Readiness Level: 7 - Full system prototype tested in a controlled environment

Patent Status:

Thermoacoustic Refrigerators and Engines Comprising Cascading Stirling Thermodynamic Units, US Patent No. 8,468,838 (DOE S-112,947), Patent Publication Date: June 25, 2013

Licensing Status:

Available for exclusive or non-exclusive licensing and collaborative agreements.

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